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OPERATION OF AUTOMATIC-TRANSFER MACHINE LINES IN SOVIET AUTOMOBILE AND TRACTOR PLANTS

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The growth of Soviet machine-tool building during the postwar years has been characterized by the construction of more productive types of machines than those produced previously. An increase in the productivity of metal-cutting machine tools has been achieved by increasing the speed of cutting and by making more processes automatic. The relative number of nonautomatic machine tools is decreasing steadily. In 1946 the output of semiautomatics comprised 31 percent of the total number of machine tools produced, while in 1948, this figure was 50 percent. The proportion of machines operating on a completely automatic cycle also has increased considerably.

Until recently, making the metal-cutting machine-tool cycle automatic was based on mechanical devices such as guiding or cam shafts which carried cam gears. These systems were complex, and their resetting required too much time to meet the needs of modern machine-tool building.

At present, electric and hydraulic units and apparatuses are being used more and more widely. These are considerably more flexible and easy to handle than automatic systems which are purely mechanical.

There are various methods of making machine tools automatic. Among the more effective is the combination of hydraulic and electric automatization, in which the working parts are operated on hydraulic drive and the control units on electric. The model 1266 six-spindle hydroelectric automatic is built on this priciple

The development of automatic and semiautomatic machines is not confined to the increased proportion of these machines, but includes the building of sets of automatics, known as automatic-transfer machine lines.

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The greater part of these automatic lines were designed for machining automobile and tractor parts. They perform drilling, boring, milling, and other operations. However, the number of automatic-transfer machine lines performing such operations as turning and grinding is comparatively small. Also, the automatization of blanking and assembly operations is still far from adequate.

Introduction of these lines has decreased the number of workers needed three to four times and has considerably reduced machining costs. The expense involved in automatization can pay for itself in 2 to 2½ years.

Experience in putting automatic lines into operation has disclosed a number of defects which are obstructing further increase in output of products from these lines. These defects must be taken into account when planning new and similar automatic lines.

Because of the lack of experience of designers, manufacturers, and consumers, the first lines produced at machine-tool building plants had a number of shortcomings. Substantial production losses were suffered during the first period of their operation.

The following table shows the performance of four automatic-transfer machines lines at an automobile plant. These lines machine automobile engine blocks.

Line No	Purpose	No of Multi-spindle Heads	No of Cutting Tools	No of Electric Apparatuses (excluding motors)	No of Hydraulic Apparatuses (excluding cyl ders)
A261-A268	Machining holes on front surfaces of block	8	57	127	50
A291-A306	Machining holes on top and first side surfaces	15	194	227	86
A421-A434	Machining holes on bottom and second side surfaces	14	226	202	96
A413-A417	Machining valve holes from top surface of block	7	67	106	48

The lines were operating under very difficult conditions. To insure a large output, they were running on a three-shift basis without substitutions and were serviced by six workers and two setters. In the process of tuning up these lines, a large number of kinks were discovered. For the most part these were caused by poor-quality electric apparatuses and hydraulics. The majority of these faults have been corrected, and at present the lines are operating well, maintaining the required output of engine blocks.

In a recent 21-shift study of the lines' operation, engineers attempted to locate and determine the causes behind the remaining flaws in the lines' performance.

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The largest time losses are due to organizational difficulties and faults in mechanisms and cutting tools. The losses due to these three factors comprises approximately 95 percent of all losses. Losses due to electric or hydraulic apparatuses are insignificant. The causes of these time losses on automatic lines have been determined and can be remedied on existing lines as well as in the design of future lines.

Losses per machine tool due to faulty mechanisms comprise approximately 0.5 percent of the total working time. Some of the reasons are: (1) the spindles in the gear housing go out of order due to wear of the driving-gear key; (2) the tapered roller bearings frequently go out of order because of insufficient hardness; (3) the bearing races become heated and crack as a result of spindle rotation on the inner races; (4) washers for preventing self-unscrewing are of inadequate thickness (0.05,0.07 millimeter); (5) in some of the machine tools (Models A291, A293, A296), lubrication has not been provided for the front bearings, and consequently go out of order.

The lack of interchangeable parts and units hinders their repair and replacement. Lack of data on the furability of individual parts which are most susceptible to wear makes it impossible to replace them in time. This can cause damage during operation when the parts go out of order. Another serious source of trouble is poor chip removal.

Many of the specified defects have been corrected in existing lines, and will not be repeated in the new ones being built. Careful designing and high-quality manufacture of machine tools for automatic lines will cut losses due to mechanical deficiencies down to 0.2-0.3 percent per machine tool.

Losses due to cutting tools are also extremely high, comprising approximately 0.1 percent per tool. There are two causes for this: (1) losses due to tool wear and replacement; (2) incidental losses due to tool breakage, premature wear, etc. In view of the fact that automatic lines operate on three shifts at the plant, dull tools are changed during working hours. Therefore, losses are considerably increased by stoppage of the line for tool replacement.

Tools for these machines should be made to last in multiples of 4, 8, 12, or 16 hours so that they can be replaced between shifts or during lunch recess.

With regular tool changes, losses due to breakage or incidental wear decrease rapidly. In existing designs of spindles, the time required for changing one tool (drill or mill) is 6-7 minutes. This time can be cut considerably by using high-speed chucks or devices which would align the tool longitudinally. As a precaution against drill, tap, or other tool breakage, at least in most hazardous instances, special safety chucks should be used. To avoid damage in the event of tool breakage during a previous operation, a device should be developed which would check the hole for depth and stop the line if the hole has not been machined to the required depth or if it has been clogged by a piece of broken tool. At present, losses due to tap breakage are very large. These losses can be decreased by using devices which will remove chips from holes, attachments for automatic lubrication of taps, and special safety chucks.

Providing for tool change during standstill time and elimination of existing defects in design of tools and jigs should cut losses caused by tools to one half or one third the present volume.

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Losses caused by electric apparatuses in the total volume of losses on lines, as was indicated earlier, are insignificant. However, it does not follow that efforts to improve the quality of electric apparatuses and the reliability of the control circuit should be relaxed. At present, losses per electric unit in automatic lines comprise approximately 0.01 percent. The fundamental causes of losses is the poor quality of the apparatus. To decrease the losses, the control circuit should contain a minimum of contacts and coils. Centralized control permits cutting the number of electrical units in half in comparison with series control systems. Reliability of the circuit can be increased by using checking apparatuses, which do not participate directly in the machine's operating cycle, but which check the work of separate sections and make it possible to locate the source of trouble quickly.

Losses caused by hydraulic units also do not exceed 0.01 percent per unit and are a result mainly of the quality of manufacture. For example, a cast-iron gear of the rotary pump frequently goes out of order. Replacing it with a heat-treated steel gear would increase the serviceability of the pump. In previous models of the U424 hydraulic panel, leakage of oil was observed; there was knocking in the flow valve and sometimes levers, supports, etc, broke off, Most of these defects have now been corrected.

At present, organizational difficulties cause the largest proportion of all losses. They are mainly the result of untimely correction of mechanical troubles, interruptions in supply of billets, delayed tool change, and the three-shift operation of automatic lines, which is not normal. Overcoming these troubles would cut organizational losses in half.

At present, total time losses on one multispindle machine tool in a line does not exceed 3.4 percent of the total operating period. Improved designs of machine tools and mechanisms, better quality of manufacture, and improved operating conditons could cut these losses to 2-2.5 percent per multispindle machine tool, Losses on one ten-machine-tool line at present comprise approximately 35 percent of operating time. This can be decreased to 20-25 percent and even less. That this can be accomplished is confirmed by operation of the A421-A434 automatic line, which consists of 14 machine tools, on which the total time losses comprise only 25.64 percent.

Successes achieved by machine-tool builders in the automatization of general-purpose universal machine tools and high-production, quickly set-up automatics have opened the way to the manufacture of general-purpose machine tools of great productivity and high degree of automatization which will be equally suitable for use in mass or series production. Solution of this problem will wipe out the barrier between the high-production but little-specialized machine tools which are used at present in mass production and the widely universal but low-production machine tools used for series production.

Positive results obtained in drilling and boring operations in automatic lines, and sufficiantly reliable performance in milling and turning and other operations in some automatic lines testify that grinding, milling, gear cutting, and similar types of work on automatic converyer lines are feasible. Machine tools for these lines should be designed as independent combination units (similar to drilling and boring combinations and other such machine tools).

Preliminary results of making blanking operations automatic show the urgent need for further development of such operations, in particular the development of automatic blanking lines consisting of reliable machines for forging, forming, casting, and similar operations.

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Assembly processes of a number of machines and mechanisms, especially of small parts (bearings), are monotonous and extremely tedious operations. These, too, can be made automatic. Construction of automatic assembly lines will permit a considerable improvement in production conditions and raise labor productivity.

Work must be pushed on the development of automatic lines for complete machining of particularly massive parts such as crank and cam shafts.

In the field of checking and measuring devices, both on lines and on units, large gains have been made. The pneumatic-electric transmitting elements of instruments have proved themselves particularly effective. At present, however, the majority of automatic machine tools being produced do not have built-in devices for checking machining precision. Attempts are being made to develop such devices in grinding machines; in lathes, milling, boring, and other machines, reliable apparatuses of this type have not yet been developed.

Despite the great achievements in the development of reliable electric apparatuses, existing designs of the majority of electric apparatuses are not satisfying the increased demands of Soviet industry. Their basic shortcomings are their large size and lack of facilities for feeding several controls off one apparatus.

Existing designs of hydraulic tubes possess sufficient reliability in operation, but require continuous adjustment and are very sensitive to temperature changes, quality of oil, and other conditions.

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